(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 296 484 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.03.2003 Bulletin 2003/13

(51) Int Cl.[7]: **H04L 12/28**, H04L 12/403, H04L 12/413

(21) Application number: **02254666.7**

(22) Date of filing: **03.07.2002**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **20.09.2001 KR 2001058361**

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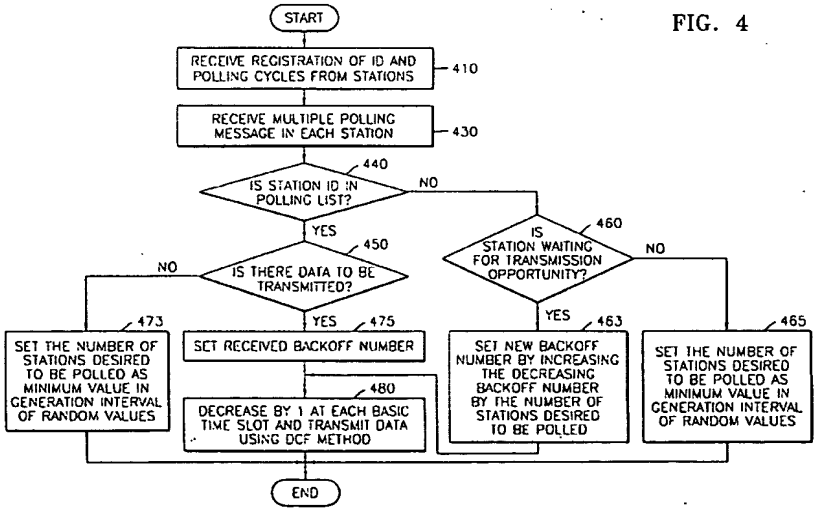
(54) Data communications method using backoff number control and a station for carrying out the method

(57) A method for transmitting data in a centralized data communications system using a carrier sense multiplexing access (CSMA) method is provided. The data transmission method uses a backoff number control in a centralized data communications system formed with an access point and stations, the method comprising (a) receiving a multi-poll message containing backoff numbers to be assigned to each station by the access point; (b) setting the backoff numbers of the multi-poll message to the backoff numbers of the stations; and (c) counting down the set backoff numbers and transmitting data. Each station that desires polling registers a station ID and a polling cycle, sets a backoff number contained in a multi-poll message, counts the backoff number, and if the backoff number becomes '0', transmits data such that contention between stations can be prevented. The data transmission method can be applied for controlling media access of a wireless LAN or Home PNA such that time-limited services can be supported. Also, with simple implementation, the method can be easily applied to existing systems such that the method can support real time service in low priced systems.

FIG. 4



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Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a centralized data transmission method using a carrier sense multiplexing access (CSMA) method, and more particularly, to a data transmission method in which an access point transmits data by transmitting a multi-poll message using the CSMA method.

[0002] FIG. 1 is a diagram showing a prior art approach for transmitting data using a distributed coordination function (DCF) method for centralized data communications using a carrier sense multiplexing access (CSMA) method.

[0003] In a CSMA centralized data communications system using such as a wireless LAN system based on IEEE 802.11, in order to minimize contention, each station generates a random backoff number. Then, if the channel is idle more than a predetermined time (DCF Inter Frame Space, DIFS), the station decreases successively the backoff number, and if the backoff becomes 0, the station transmits data. This is referred to as a DCF method. Here, the backoff number is randomly generated between the minimum value (CWmin) and the maximum value (CWmax) of a contention window (CW) determined by an access point.

[0004] Referring to FIG. 1, station 1 transmits data, the backoff numbers of station 2 and station 3 are 3 and 5, respectively. One DIFS after station 1 ends data transmission, the backoff number of station 2 is counted down, and data is transmitted. When data of station 2 is transmitted, counting down of the backoff number of station 3 is stopped. One DIFS after station 2 ends data transmission, the remaining backoff number of station 2 is counted down, and when the backoff number becomes 0, data is transmitted.

[0005] Since the DCF method works on a probability basis, there is a high possibility of contention between data transmitted by stations. Also, since the number and size of data packets are not controlled by the access points, it is difficult to support time-limited services.

[0006] FIG. 2 is a diagram showing a prior art data transmission method using a point coordination function (PCF), in which a contention free period (CFP) can be controlled by an access point is set, and transmission opportunities are provided to each station based on a polling method. This will be referred to as a point coordination function (PCF) method. In the PCF method, PCF Inter Frame Space (PIFS) and Short Inter Frame Space (SIFS) that are shorter than the DIFS are used instead of the DIFS in order to obtain priority over DCF-using stations.

[0007] However, in wireless LAN systems, for example, Intersil and ATmel, the PCF function is not offered due to the complexity of implementation.

[0008] FIG. 3 is a diagram showing a data transmission method of a centralized data communications system using the CSMA, in which contention period (CP) intervals and contention free period (CFP) intervals are mixed and used together.

[0009] A beacon message contains information on CFP intervals or CP intervals, or beacon message intervals. One SIFS interval after one station ends data transmission, an access point transmits a polling message (D1 + Poll, D2 + ack + Poll, D3 + ack + Poll).

[0010] The DCF method is used during the CP interval, while the PCF method is used during the CFP interval. Since the DCF method depends on transmission opportunity obtaining based on probability, it is difficult to support time-limited services. Therefore, polling stations using the PCF method during the CFP interval allow time-limited services. However, in the PCF method, a polling message should be transmitted whenever polling stations is performed, and additional timing management for the CFP intervals is needed. Thus, implementation is complicated.

[0011] Also, since the CFP interval is fixed, data transmitted by a polled station may exceed the CFP interval. In this case the station has to give up the PCF transmission, and transmit data in a CP interval on a contention basis. For example, when stations that received polling messages transmit data and a confirmation message (U1 + ack, U2 + ack or U3 + ack) to confirm the transmission of data, a station which desires to transmit U3 data cannot transmit the data in the CFP interval and has to transmit them in the CP interval.

[0012] If a polled station is to transmit continuous fragmented data, and if a data item exceeds the CFP interval, the station has to transmit the data during the CP interval. In addition, it is necessary to adjust the lengths of a transmission frame and a CFP interval in order to practically support time-limited services, and for some services, if very short interval polling is requested, polling in the CP interval as well as polling in the CFP interval will be needed. To solve this, the length of a transmission frame should be shorter than a corresponding polling cycle interval.

[0013] According to the invention, there is provided a data transmission method using a backoff number control in a centralized data communications system formed with an access point and stations, the method comprising (a) receiving a multi-poll message containing backoff numbers to be assigned to each station by the access point; (b) setting the backoff numbers of the multi-poll message to the backoff numbers of the stations; and (c) counting down the set backoff numbers and transmitting data.

[0014] The invention also relates to a method of operating an individual station in a data transmission system using a backoff number control in a data communications system formed with an access point and stations, the method comprising:

(a) receiving a multi-poll message containing the backoff numbers for each station in a polling list from the access point;

(b) if the station is in the polling list, setting the back-

off number to be the corresponding backoff number of the station in the multi-poll message;

if the station is not in the polling list but is waiting for a transmission opportunity, setting a new backoff number by increasing the backoff number of the station by the number of stations in the polling list; and

(c) counting down the set backoff numbers and transmitting data when the backoff number is zero.

[0015] The present invention thus provides a data transmission method using a backoff number control in a CSMA centralized data communications system.

[0016] The invention also provides a computer readable recording medium having the data transmission method therein.

[0017] The advantages of the present invention will become more apparent by the description in detail of preferred embodiments with reference to the attached drawings in which:

FIG. 1 is a diagram showing a prior art approach for transmitting data using distributed coordination function (DCF) method for centralized data communications using a carrier sense multiplexing access (CSMA) method;

FIG. 2 is a diagram showing a method for polling with a point coordination function (PCF) in prior art centralized data communications using the CSMA method;

FIG. 3 is a diagram showing a data transmission method in which contention period (CP) intervals and contention free period (CFP) intervals are mixed and used together;

FIG. 4 is a flowchart showing a data transmission method using a backoff number control according to the present invention;

FIG. 5 is a diagram of a data transmission frame for a data transmission method using a backoff number control according to the present invention;

FIG. 6 is a diagram of the structure of a multi-poll message for a data transmission method using a backoff number control according to the present invention; and

FIG. 7 is a diagram of a preferred embodiment of a data transmission method using a backoff number control according to the present invention.

[0018] FIG. 4 is a flowchart showing a data transmission method using a backoff number control in a CSMA centralized data communications system according to the present invention, in which if an access point transmits a multi-poll message, the stations receive the message, set backoff numbers, and transmit data according to the backoff numbers.

[0019] Each station registers information containing a station ID and a polling cycle to the access point in step 410. The access point calculates the lengths of transmission frames based on the registered polling cycles, and randomly generates backoff numbers. Here, assuming that the interval of random values is within a contention window (CW), the access point sets the backoff numbers. From the information registered in step 410, the access point transmits a multi-poll message containing the number of stations that want polling, the IDs of those stations, or backoff numbers to be assigned to the stations.

[0020] Each station receives the multi-poll message transmitted by the access point in step 430. If the station ID is in the polling list of the multi-poll message in step 440, and if the station has data desired to be transmitted in step 450, the station sets a backoff number in the received multi-poll message corresponding to the ID of the station in step 475 to prepare to transmit data. The station which set the backoff number in step 475 transmits data using the DCF method by decreasing the backoff number at each basic time slot in step 480. If there is no data to be transmitted in step 450, the number of stations that want polling is set as the minimum value in a contention window in step 473, and then if there is data to be transmitted, a backoff number which is randomly generated between the minimum value and the maximum value in the Contention Window set in step 473 and is transmitted by the access point is received and set, and data is transmitted.

[0021] When the ID of the station is not in the polling list of the received multi-poll message in step 440, and the station is waiting to obtain a transmission opportunity in step 460, the decreasing backoff number is increased by the number of stations desired to be polled, and a new backoff number is set in step 463, and by decreasing the new backoff number by 1 at each basic time slot, data is transmitted using the DCF method in step 480. When the ID of the station is not in the polling list of the received multi-poll message in step 440 and the station is not waiting to obtain a transmission opportunity in step 460, the number of stations desired to be polled is set as the minimum value in a contention window in step 465, and then, if there is data to be transmitted, a backoff number which is randomly generated between the minimum number and the maximum number in the contention window set in step 465 and is transmitted by the access point is received and set, and data is transmitted.

[0022] FIG. 5 is a diagram of the structure of a data transmission frame for a data transmission method according to the present invention. A transmission frame is formed with beacon message information containing the interval of CP or the interval of a beacon message transmitted by the access point, a multi-poll message, and data transmitted by each station. The time interval between a beacon message and a multi-poll message is variable, and the time interval for transmitting each data (D1 through D5) is a DIFS. The time when a polling message is transmitted is variable, because the polling cycle registered by each station is confirmed and ac-

cording to the cycle, the polling message is transmitted. Also, since a plurality of multi-poll messages can be transmitted in one transmission frame interval (length), the polling interval is also variable.

[0023] FIG. 6 is a diagram of the structure of a multi-poll message for a data transmission method according to the present invention, in which the number of stations that want polling, and the ID and backoff number of each station are included.

[0024] If the access point transmits a multi-polling message having the structure shown in FIG. 6 during an interval which is shorter than a DIFS, after a beacon message is transmitted, each station sets a backoff number corresponding to the ID of the station, and then transmits data in a DIFS interval.

[0025] FIG. 7a is an embodiment of a multi-poll message according to the present invention. Since the number of stations that want polling is 3, backoff numbers 0, 1, and 2 are assigned to stations 1, 2, and 3, respectively.

[0026] FIG. 7b is a diagram of a data transmission method according to the present invention, showing an embodiment of a station transmitting data.

[0027] Referring to FIGS. 7a and 7b, the embodiment will now be explained.

[0028] If an access point transmit a multi-poll message as shown in FIG. 7a, stations 1 through 4 receive the multi-poll message, check registered IDs and backoff numbers, set assigned backoff numbers and then transmit data.

[0029] Since the backoff number of station 1 is 0, station 1 can have a transmission opportunity immediately after receiving the multi-poll message. If the channel becomes idle a DIFS interval after station 1 ends data transmission, stations excluding station 1 decrease backoff numbers by 1 at each basic time slot, and therefore, station 2 of which backoff number becomes 0 obtains a transmission opportunity. However, since station 2 has no data to be transmitted, the channel is still idle. Since the channel is also idle for a basic time slot at this time, stations excluding stations 1 and 2 decrease the backoff numbers by 1. Then, station 3 obtains the next transmission opportunity. Since station 4 which was not in the polling list increased its backoff number up to the number of stations that want polling, when the multi-poll message is received, station 4 cannot obtain a transmission opportunity in the polling cycle. Here, the polling cycle indicates the interval between multi-poll messages.

[0030] Thus, the access point can always perform polling of the stations such that time-limited services can be effectively supported.

[0031] The present invention may be embodied in a code, which can be read by a computer, on a computer readable recording medium. The computer readable recording medium includes all kinds of recording apparatuses on which computer readable data are stored. The computer readable recording media includes storage media such as magnetic storage media (e.g., ROM's, floppy disks, hard disks, etc.), optically readable media (e.g., CD-ROMs, DVDs, etc.) and carrier waves (e.g., transmissions over the Internet). Also, the computer readable recording media can be scattered among computer systems connected through a network and can store and execute a computer readable code in a distributed mode. Also, the structure of data or a database required in performing the method according to the present invention may be recorded in the recording medium as described above and by operating the computer program, desired functions and effects may be obtained.

[0032] According to the present invention as described above, the data transmission method using a backoff number control in a CSMA centralized data communications system is applied for controlling media access of a wireless LAN or Home PNA such that time-limited services can be supported. Also, with simple implementation, the method can be easily applied to existing systems such that the method can support real time service in low priced systems.

Claims

1. A data transmission method using a backoff number control in a centralized data communications system formed with an access point and stations, the method comprising:

   (a) receiving in the stations a multi-poll message from the access point, the multi-poll message containing backoff numbers to be assigned to each station in a polling list;
   (b) setting the backoff numbers in the stations in the polling list to be the corresponding backoff numbers of the multi-poll message; and
   (c) counting down the set backoff numbers in the station and transmitting data.

2. The method of claim 1, further comprising:

   registering to the access point the IDs and polling cycles of stations that are to be polled.

3. A method of operating a station in a data communications system using a backoff number control, the data communications system being formed with an access point and stations, the method comprising:

   (a) receiving a multi-poll message containing the backoff numbers for each station in a polling list from the access point;
   (b) if the station is in the polling list, setting the backoff number to be the corresponding backoff number of the station in the multi-poll mes-

sage;

if the station is not in the polling list but is waiting for a transmission opportunity, setting a new backoff number by increasing the backoff number of the station by the number of stations in the polling list; and

(c) counting down the set backoff numbers and transmitting data when the backoff number is zero.

4. The method of claim 1, 2 or 3, wherein in step (a) the multi-poll message contains at least one of the number of stations that are to be polled, the IDs of those stations, and the backoff numbers of the stations.

5. The method of claim 4, wherein the multi-poll message contains the IDs of the stations to be polled, and the backoff numbers of those stations, the method including in step (b) checking in the stations the ID of the station against the IDs of the stations in the multi-poll message and if the station ID is in the multi-poll message setting the backoff number of the station to be the backoff number in the multi-poll message corresponding to the station.

6. The method of any preceding claim, wherein in step (c) the set backoff number is counted down and when the backoff number becomes 0, data is transmitted.

7. The method of any preceding claim, further comprising the step of, in a station having no data to be transmitted among the stations to be polled, randomly setting a backoff number using the number of stations that are to be polled as the minimum value in an interval of random values to be generated.

8. The method of any preceding claim, further comprising the step of, in a station which is not among the stations that are to be polled but which waits to obtain a transmission opportunity, resetting the backoff number to a value obtained by adding the number of stations that want polling to the backoff number.

9. The method of any preceding claim, further comprising the step of, in a station which is not to be polled and which does not wait to obtain a transmission opportunity, randomly setting a backoff number using the number of stations that are to be polled as the minimum value in an interval of random values to be generated.

10. A computer readable medium having embodied thereon a computer program for the method of any one of claims 1 through 8.

11. A station containing code for carrying out a method according to claim 3 or any of claims 4 to 9 when dependent on claim 3.

FIG. 1

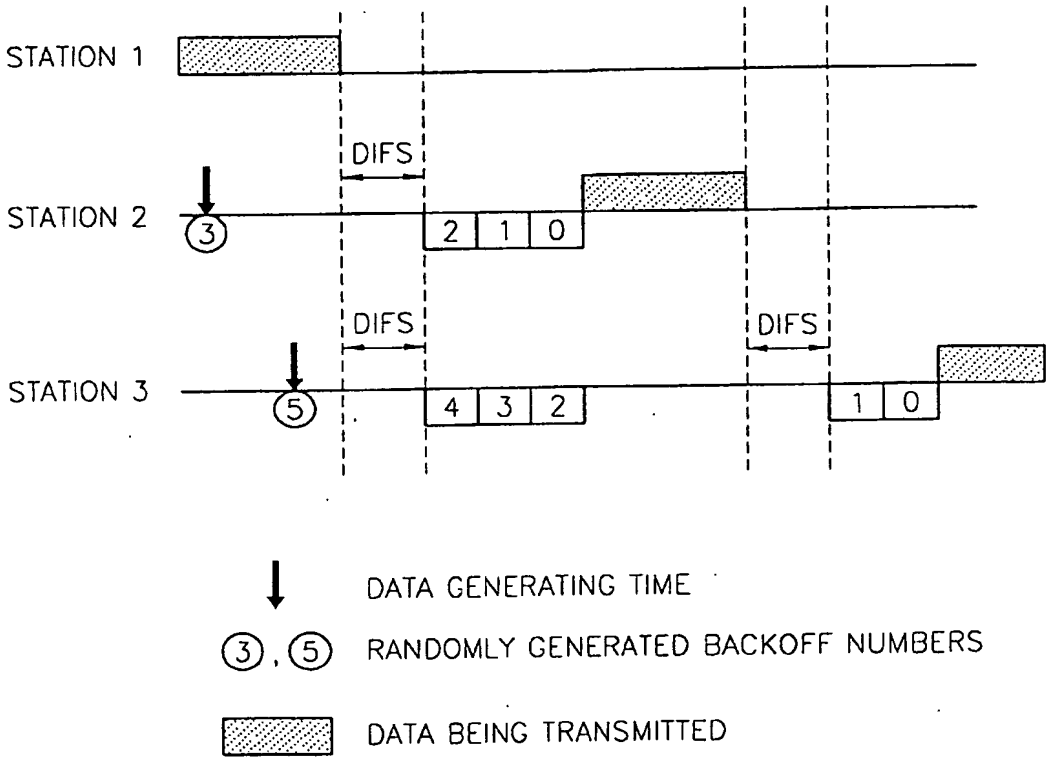

STATION 1
DIFS
STATION 2
3
2
1
0
DIFS
DIFS
STATION 3
5
4
3
2
1
0
DATA GENERATING TIME
3, 5
RANDOMLY GENERATED BACKOFF NUMBERS
DATA BEING TRANSMITTED

FIG. 2

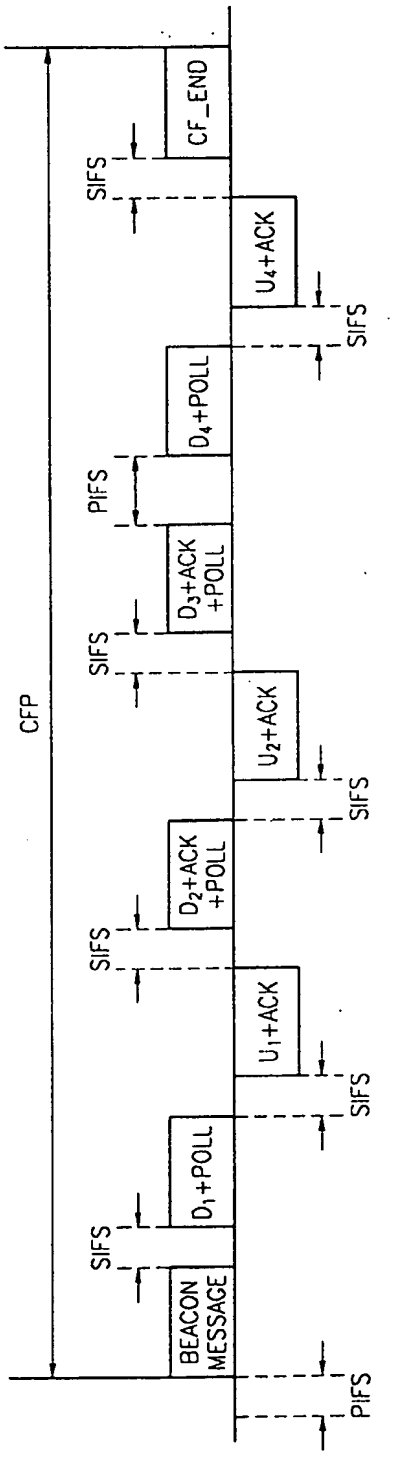

CFP
BEACON MESSAGE
SIFS
D1+POLL
SIFS
U1+ACK
SIFS
D2+ACK +POLL
SIFS
U2+ACK
SIFS
D3+ACK +POLL
PIFS
D4+POLL
SIFS
U4+ACK
SIFS
CF_END
PIFS

FIG. 3

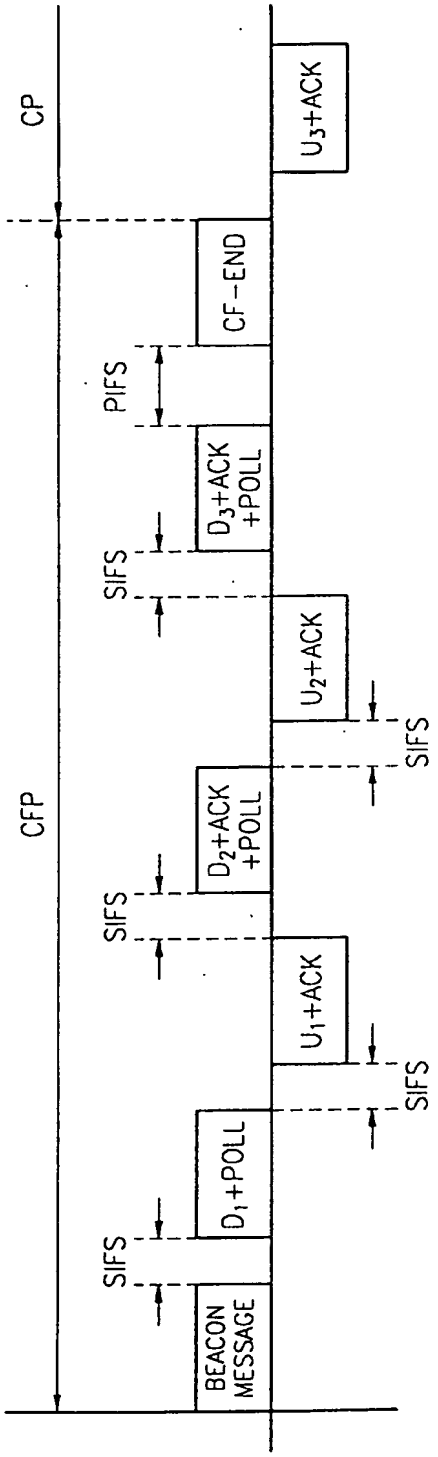

CP
CFP
BEACON MESSAGE
SIFS
D1+POLL
SIFS
U1+ACK
SIFS
D2+ACK +POLL
SIFS
U2+ACK
SIFS
D3+ACK +POLL
PIFS
CF-END
U3+ACK

FIG. 4

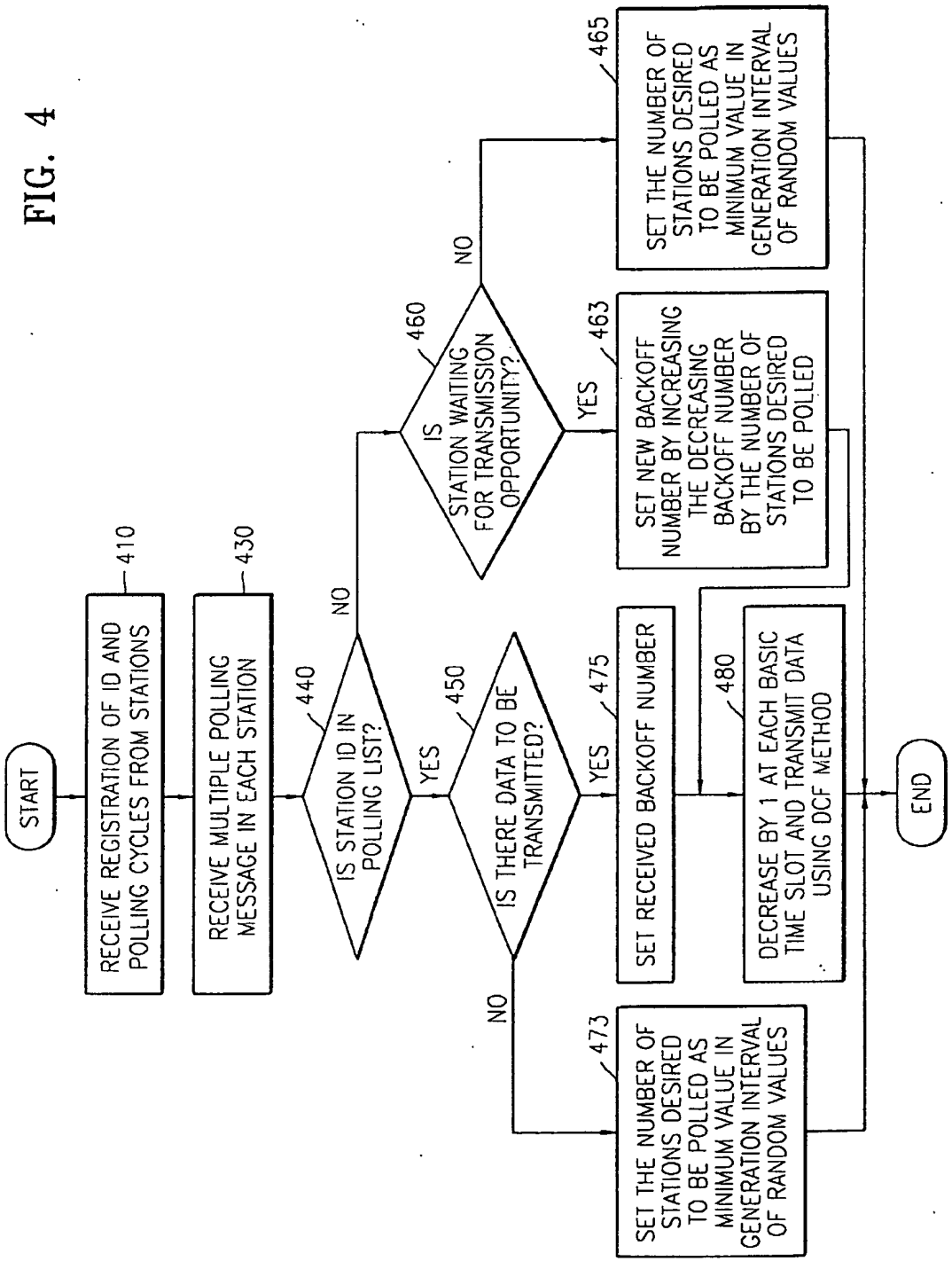

START
410
RECEIVE REGISTRATION OF ID AND POLLING CYCLES FROM STATIONS
430
RECEIVE MULTIPLE POLLING MESSAGE IN EACH STATION
440
IS STATION ID IN POLLING LIST?
NO
460
IS STATION WAITING FOR TRANSMISSION OPPORTUNITY?
NO
465
SET THE NUMBER OF STATIONS DESIRED TO BE POLLED AS MINIMUM VALUE IN GENERATION INTERVAL OF RANDOM VALUES
YES
463
SET NEW BACKOFF NUMBER BY INCREASING THE DECREASING BACKOFF NUMBER BY THE NUMBER OF STATIONS DESIRED TO BE POLLED
YES
450
IS THERE DATA TO BE TRANSMITTED?
NO
473
SET THE NUMBER OF STATIONS DESIRED TO BE POLLED AS MINIMUM VALUE IN GENERATION INTERVAL OF RANDOM VALUES
YES
475
SET RECEIVED BACKOFF NUMBER
480
DECREASE BY 1 AT EACH BASIC TIME SLOT AND TRANSMIT DATA USING DCF METHOD
END

FIG. 5

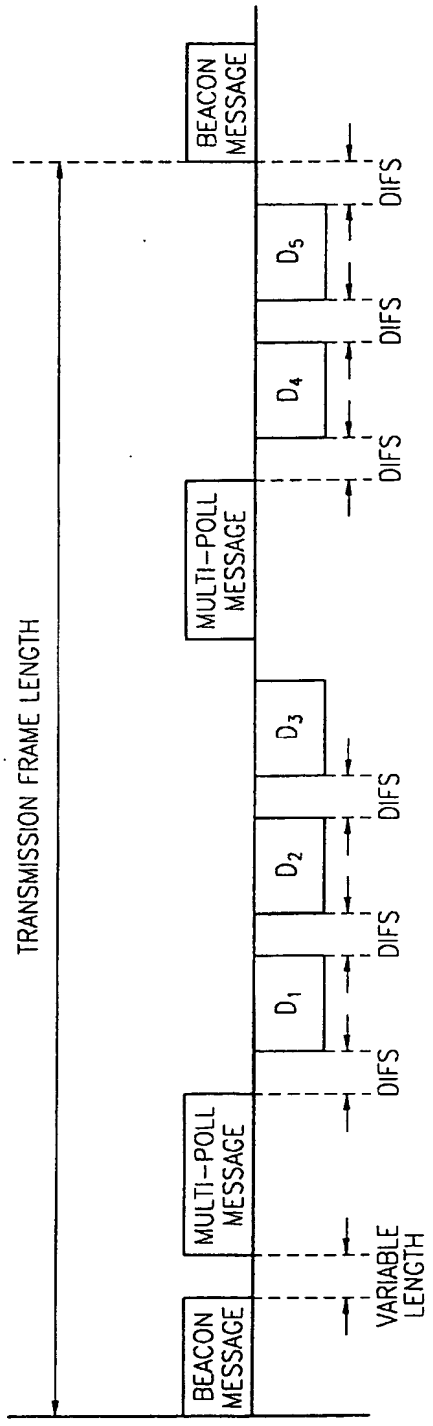

TRANSMISSION FRAME LENGTH
BEACON MESSAGE
MULTI-POLL MESSAGE
VARIABLE LENGTH
DIFS
D_1
D_2
D_3
MULTI-POLL MESSAGE
D_4
D_5
BEACON MESSAGE

FIG. 6

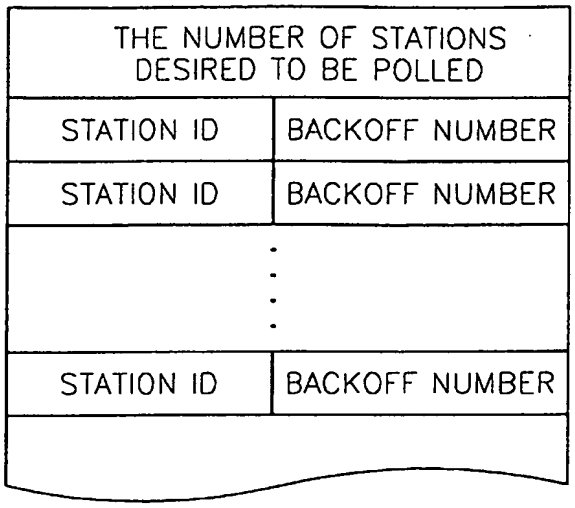
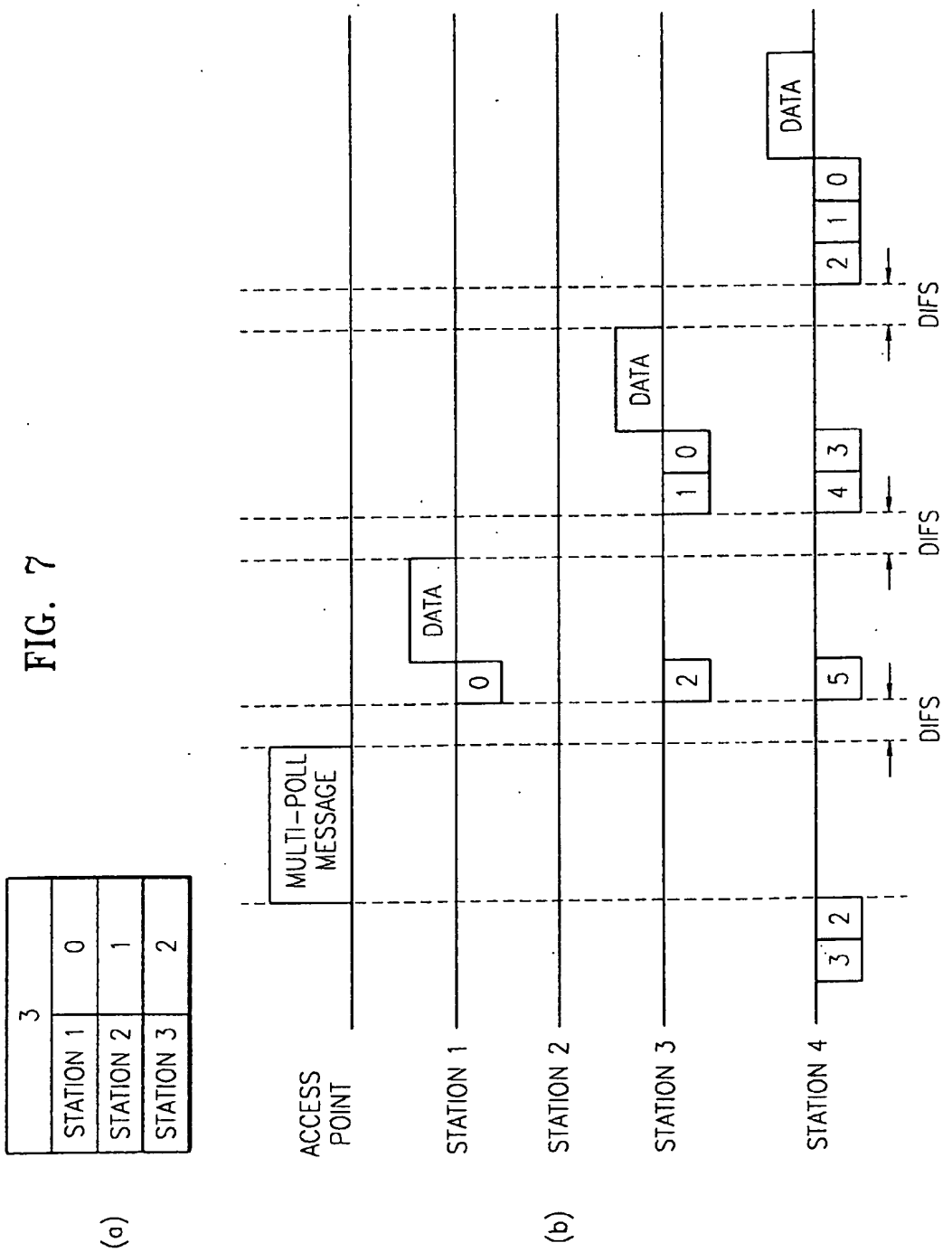

THE NUMBER OF STATIONS DESIRED TO BE POLLED
STATION ID
BACKOFF NUMBER
STATION ID
BACKOFF NUMBER
STATION ID
BACKOFF NUMBER

FIG. 7


(a)
3
STATION 1
0
STATION 2
1
STATION 3
2
(b)
ACCESS POINT
STATION 1
STATION 2
STATION 3
STATION 4
MULTI-POLL MESSAGE
DATA
DATA
DATA
DIFS
DIFS
DIFS
0
2
5
1
0
4
3
2
1
0
3
2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 25 4666

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	EP 0 994 604 A (LUCENT TECHNOLOGIES INC) 19 April 2000 (2000-04-19) * column 5, line 7-10 * * paragraphs [0031]-[0034]; figures 5,11 * * paragraphs [0037]-[0040]; figure 6 * * paragraphs [0068],[0069]; figures 14A,B,C *	1,6,10 2,4,5	H04L12/28 H04L12/403 H04L12/413
Y	EP 0 652 523 A (NIPPON ELECTRIC CO) 10 May 1995 (1995-05-10) * abstract * * column 3, line 27-42 * * column 4, line 12-22; figure 2 *	2	
Y	EP 0 483 546 A (IBM) 6 May 1992 (1992-05-06) * column 8, line 45 - column 9, line 21; figure 3 * * column 9, line 58 - column 11, line 4 * * column 12, line 26-34 *	4,5	
A	DENG D-J ET AL: "A PRIORITY SCHEME FOR IEEE 802.11 DCF ACCESS METHOD" IEICE TRANSACTIONS ON COMMUNICATIONS, INSTITUTE OF ELECTRONICS INFORMATION AND COMM. ENG. TOKYO, JP, vol. E82-B, no. 1, January 1999 (1999-01), pages 96-102, XP000927880 ISSN: 0916-8516 Section 3.2 "Shorter Random Backoff Time" * page 99 *		TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04L H04Q G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	29 January 2003	Milano, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 02 25 4666

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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29-01-2003

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